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EXAMINER	
ZERVIGON, R	

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Please find below and/or attached an Office communication concerning this application or proceeding.

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1- File Copy

Office Action Summary	Application No. **08/988,246**	Applicant(s) **Sebastien et al**
	Examiner **Rudy Zervigon**	Art Unit **1763**

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE ___3___ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Apr 23, 2001*

2a) ☐ This action is **FINAL.** 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle* 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *3-14, 16, 19-24, and 26-30* is/are pending in the applica

4a) Of the above, claim(s) *7-10* is/are withdrawn from considera

5) ☐ Claim(s) ______ is/are allowed.

6) ☒ Claim(s) *3-6, 11-14, 16, 19-24, and 26-30* is/are rejected.

7) ☐ Claim(s) ______ is/are objected to.

8) ☐ Claims ______ are subject to restriction and/or election requirem

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

11) ☐ The proposed drawing correction filed on ______ is: a) ☐ approved b) ☐ disapproved.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15) ☐ Notice of References Cited (PTO-892)

16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). ______

18) ☐ Interview Summary (PTO-413) Paper No(s). ______

19) ☐ Notice of Informal Patent Application (PTO-152)

20) ☐ Other:

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 3, 4, 6, 11-14, 16, 19, 20, 23, 24, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Salimian et al (U.S.Pat. 5,656,123) in view of Patrick et al (U.S.Pat. 5,474,648) and Kinoshita et al (U.S.Pat. 5,795,452), Maher et al (U.S.Pat. 5,248,371), Tadahiro Ohmi (U.S.Pat. 5,272,417). Salimian et al describe a plasma reactor suited to <u>both</u> additive and subtractive processes (column 1, lines 5-17). Specifically, Salimian et al describe:

i. A substrate processing system (item 10, Figure 1) using a deposition chamber (item 14, Figure 1; column 5, lines 38-64) encasing a reaction zone

ii. A substrate processing system using a substrate holder as a low frequency (LF) electrode (item 46, Figure 1; column 7, lines 27-34)

iii. A gas introduction system including a gas inlet (item 44, Figure 1) for supplying one or more process gas(es) to the reaction zone

iv. A high frequency (HF) electrode (column 7, lines 27-34)

v. A plasma power source (items 12, 16, Figure 1; column 5, lines 38-45) for forming plasma within the reaction zone of the additive or subtractive reaction zone (column 1, lines 5-17)

vi. impedance measuring of the HF electrode (column 7, lines 35-40)

vii. impedance measuring of the LF electrode (column 6, lines 24-28)

Salimian et al do not expressly meet the claim 11 limitations of an impedance monitor electrically coupled to each of the low and high frequency electrodes. Additionally, Salimian et al do not discuss a gas distribution system including a gas inlet manifold. Commonly in the art, a gas distribution system including a gas inlet manifold is referred to a showerhead that is customarily used as a counter electrode opposite the chamber electrode supporting the processed substrate. As such, a gas distribution system including a gas inlet manifold (showerhead) is well described in the art. The gas distribution system thus claimed is amply reflective in entire subclasses 204/432, 438/729, 118/723E, 156/345 and is demonstrated clearly by Maher et al (item 90 all figures, column 8, lines 52-65) who describes a plasma processing triode reactor (column 2, lines 41-49).

The Tadahiro Ohmi patent is similar to the Salimian et al patent and complements the claim 11 limitations accordingly:

viii. A substrate processing system (Figure 1a) using a deposition chamber (item 105, Figure 1a; column 6, lines 25-38) encasing a reaction zone

ix. A substrate processing system using a substrate holder as a low frequency (LF) electrode (item 104, Figure 1a; column 6, lines 26-27)

x. A gas introduction system including a gas inlet (item , Figure) for supplying one or more process gas(es) to the reaction zone

xi. A high frequency (HF) electrode (item 107, Figure 1a; column 6, lines 25-27)

xii. A plasma power source (items 111, 110, Figure 1a; column 6, lines 63-69) for forming plasma within the reaction zone of the additive or subtractive reaction zone (column 1, lines 5-17)

Roger Patrick et al (U.S.Pat.5,474,648) details a dynamic control and delivery of radio frequency power in plasma process systems. **The processing is utilized to enhance the repeatability and uniformity of the process plasma. Power, voltage, current, phase, *impedance*, harmonic content and direct current bias of the radio frequency energy being delivered to the plasma chamber may be monitored at the plasma chamber and used to control or characterize the plasma load.** Dynamic pro-active control of the characteristics of the radio frequency power to the plasma chamber electrode during the formation of the plasma enhances the uniformity of the plasma (ABSTRACT).

Specifically, Roger Patrick et al describes the claim 1 limitation of ***an impedance monitor electrically coupled to the deposition chamber to measure an impedance level*** **of the process plasma is explicitly met from column 3**:

ling the radio frequency energy with a computer system. In addition, the voltage, current, phase and impedance of the plasma chamber electrode may also be measured and the measurement information used by the computer power con-

Additionally, from column 4:

4

trol system of the present invention.

A control system that monitors and controls the radio frequency power at the plasma chamber electrode is illustrated in FIGS. 2A and 2B. This radio frequency power control system includes a radio frequency sensor placed closely to the plasma load electrodes in the plasma etching

In addition the Patrick et al sensor may also measure the voltage, current and phase angle at the chamber electrode (items 112 and 114; column 6, line 64), ***and measure the chamber impedance (column 4, lines 37-40)***. Patrick et al additionally teach variable capacitors (items 106 and 108; Figure 2A) of a matching network (120, Fig.2A).

Patrick et al do not describe the following claim 11 attributes:

xiii. A substrate processing system **using a substrate holder as a low frequency (LF) electrode**

xiv. A high frequency (HF) electrode different from the **substrate holder as a low frequency (LF) electrode**

However, Patrick et al does discuss applying either or both high frequency (HF) or low frequency (LF) power to the chamber electrodes (column 1, lines 49-53). Patrick et al does precisely provide coupling of one power source to two counter electrodes with a measure of reactor impedance as described above. Kinoshita et al additionally describe this design (column 14, lines 12-20) as an embodiment in multiple embodiments of capacitively coupled plasma reactor designs (column 1, lines 5-15). Kinoshita et al does not provide, in the sixth embodiment, two power sources as is done in the fifth embodiment that very closely resembles the electrical orientation of the claimed components of the present invention. However, the Kinoshita et al item 17, Figure 7 component is provided as a phase shifter (column 13, line 49) not an impedance monitor as described according to item 17, Figure 7 (column 14, lines 12-20).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Salimian et al plasma processing reactor in view of Patrick et al and, as demonstrated by Kinoshita et al with the common gas distribution showerhead electrode as described by Maher et al.

Motivation for modifying the Salimian et al plasma processing reactor in view of Patrick et al and, as demonstrated by Kinoshita et al with the common gas distribution showerhead electrode as described by Maher et al is directed "..to provide substantially uniformity of substrate surface processing over the entire surface of the substrate." (Column 3, lines 2-4).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to implement the Tadahiro Ohmi impedance monitor electrically coupled to each of the low and high frequency electrodes.

Motivation for implementing the Tadahiro Ohmi impedance monitor electrically coupled to each of the low and high frequency electrodes is directed to providing a chamber impedance measurement and control as described by Patrick et al into Salimian et al's two power source capacitively coupled reactor with different frequency positions. The Salimian et al inventors would arrive at the presently claimed invention under motivation provided by Patrick et al (column 3, line 64 through column 4, line 18).

3. Claims 5 and 27-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Salimian et al (U.S.Pat. 5,656,123) as applied to claims 3, 4, 6, 11-14, 16, 19, 20, 23, 24, and 26 above, and further in view of Boys et al (U.S.Pat.4,500,408). Salimian et al does not teach a pressure control system based on measured plasma attributes such as impedance. Boys et al describe a magnetron sputter coating apparatus controlled in response to measurements of plasma parameters to control deposition parameters (abstract). Specifically, Boys et al describe:

xv. a pressure control system (column 12, lines 51-53) configured to control a pressure level within the chamber and controllably coupled to the processor wherein the processor controls

the pressure control system to vary the pressure within the chamber in response to the measured impedance level of the plasma (column 22, lines 61-66)

Boys et al additionally teach a plurality of impedance measuring devices as manifested by plasma voltage and plasma current measurements (items 45, 46; Fig.1; column 11, lines 43-45).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to implement the pressure control system as described by Boys et al to be an obvious extension to the Patrick et al impedance data collection and control system.

Motivation for implementing the pressure control of Boys et al based on measuring the plasma impedance as part of the Patrick et al impedance data collection and control system is directed "To control deposition rate and coating distribution accurately over a period of time, it is necessary to control both plasma voltage and plasma current for a specific plasma power. Plasma voltage and plasma current are a function of plasma impedance.....Thus the two variables that can be varied to control plasma impedance are the pressure of the working gas in volume 13 and the magnetic field applied by cathode assembly 17 to target 15 and volume 13." (Column 11, lines 40-45; lines 56-59).

4. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Salimian et al (U.S.Pat. 5,656,123) as applied to claims 3, 4, 6, 11-14, 16, 19, 20, 23, 24, and 26 above, and further

in view of Grewal et al (U.S. Pat. 5,597,438). Salimian et al does not precisely teach a high frequency power supply coupled to the high frequency electrode and a low frequency power supply coupled to the low frequency electrode. Grewal et al describes a three electrode etching chamber for plasma processing of polycrystalline silicon (column 1, lines 1-12). Specifically, Grewal et al discusses:

xvi. A process chamber (item 30, Figure 2) for processing a semiconductor substrate (column 1, lines 1-12) in a plasma (column 1, lines 40-55) where the chamber consists of ...

xvii. A primary electrode (item 36, Figure 2; column 3, lines 3-25) on the ceiling of the process chamber which supports an electrically conducting surface ("electrode", column 3, line 5) exposed to the plasma zone

xviii. A secondary electrode (item 42 Figure 2; column 3,lines 3-25) comprising a conductor element having a surface exposed to the plasma and absent an insulator shield. The secondary electrode is, additionally, below a third power electrode (item 48,Figure 2; column 3,lines 3-25).

xix. An electrode voltage supply adapted to maintain the power electrode, primary electrode, and secondary electrode at one or more different electrical potentials, thus *all power supplies are electrically <u>coupled and controlled independently</u>,* due to the three independently controlled power sources (column 3,lines 3-25). Floating electrical potentials for the secondary electrode is implicit considering the range of possible values the voltages may have

depending on process conditions and set points. Each of the electrode voltage supplies are adapted to maintain the ceiling and the electrode at different electrical potentials.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Salimian et al plasma processing reactor by implementing the independent source control as taught by Grewel at al.

Motivation for modifying the Salimian et al plasma processing reactor by implementing the independent source control as taught by Grewel at al is directed to providing increased plasma volume geometric control (anisotropic) as discussed by Grewal et al (column 2, lines 5-20).

Response to Arguments

In response to applicant's argument with regards to Patrick et al that "It does not disclose both HF and LF as alleged by the Examiner." (Page 6), it is established that Patrick et al do not describe:

xx. A substrate processing system **using a substrate holder as a low frequency (LF) electrode**

xxi. A high frequency (HF) electrode different from the **substrate holder as a low frequency (LF) electrode**

However, Patrick et al does discuss applying either or both HF or LF power to the chamber electrodes (column 1, lines 49-53). In addition the Patrick et al sensor may also measure the voltage,

current and phase angle at the chamber electrode (items 112 and 114; column 6, line 64), ***and measure the chamber impedance (column 4, lines 37-40)***.

It is conceded that Patrick et al do not have both LF and HF electrodes. However, Salimian et al remedy this deficiency:

xxii. impedance measuring of the HF electrode (column 7, lines 35-40)

xxiii. impedance measuring of the LF electrode (column 6, lines 24-28)

With regards to applicant's position concerning the Salimian et al patent that "The electrode described at column 6, lines 24-28 at 60MHz is a VHF electrode, not an LF electrode", it has been held that apparatus claims must distinguish from the prior art in terms of structure rather than function. See MPEP 2114. In the present case Salimian et al teach:

xxiv. A high frequency (HF) electrode (column 7, lines 27-34)

xxv. A plasma power source (items 12, 16, Figure 1; column 5, lines 38-45) for forming plasma within the reaction zone of the additive or subtractive reaction zone (column 1, lines 5-17)

xxvi. impedance measuring of the HF electrode (item 22, Fig.1;column 7, lines 35-40)

xxvii. impedance measuring of the LF electrode (item 20, Fig. 1; column 6, lines 24-28)

Thus Salimian et al meet the structural limitations as claimed. The frequencies applied to the respective electrodes does not patentably distinguish Salimian et al from the presently claimed structural limitations. Thus this clause does not require any particular structure beyond what is shown in the references, and therefore does not define over them.

With regards to "Nothing in Salimian et al and the other cited references teaches or suggests first and second impedance probes to measure impedance at the HF and LF electrodes, and a processor for adjusting processing conditions based on the measurements", it is clearly shown that:

Boys et al teach a plurality of impedance measuring devices ("probes") as manifested by plasma voltage and plasma current measurements (items 45, 46; Fig.1; column 8, lines 43-69; column 11, lines 43-45) including a processor (CPU 57) for adjusting processing conditions based on the measurements. Specifically, this is implemented by Boys et al "To control deposition rate and coating distribution accurately over a period of time, it is necessary to control both plasma voltage and plasma current for a specific plasma power. Plasma voltage and plasma current are a function of plasma impedance.....Thus the two variables that can be varied to control plasma impedance are the pressure of the working gas in volume 13 and the magnetic field applied by cathode assembly 17 to target 15 and volume 13." (Column 11, lines 40-45; lines 56-59).

With respect to applicant's position that "Grewal et al also fail to disclose or suggest the impedance monitor and processor as recited in claim 11 from which claim 5 depends.", it is noted in the body of the rejected claim 21, that Grewal is not used to meet the impedance monitor and processor as recited in claim 11 from which claim 5 depends. In fact, as stated above, Boys et al clearly and accurately meet this limitation.

Grewal is applied in the rejection for teaching:

"

An electrode voltage supply adapted to maintain the power electrode, primary electrode, and secondary electrode at one or more different electrical potentials, thus *all power supplies are electrically* <u>*coupled and controlled independently*</u>, due to the three independently controlled power sources (column 3,lines 3-25). Floating electrical potentials for the secondary electrode is implicit considering the range of possible values the voltages may have depending on process conditions and set points. Each of the electrode voltage supplies are adapted to maintain the ceiling and the electrode at different electrical potentials.

"

As stated in prior actions.

With regards to Mr. Lueng's request for additional clarification of the rejection to claims 16, 20 and 26, Mr. Lueng is directed to the body of the claim rejection above. With regards to the objection to claims 16, 20, and 26 made in the Office Action dated November 13, 1999, the amendment of filed February 2, 2000 was insufficient to place the application in condition for allowance after an updated search and additional consideration of the references or record.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Rudy Zervigon whose telephone number is (703) 305-1351. The examiner can normally be reached on a Monday through Thursday schedule from 8am through 7pm. The official after final fax phone number for the 1763 art unit is (703) 305-3599. Any Inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Chemical and Materials Engineering art unit receptionist at (703) 308-0661. If the examiner can not be reached please contact the examiner's supervisor, Gregory L. Mills, at (703) 308-1633.